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SOME OBSERVATIONS ON THE SPACING PATTERN OF *ANAX IMPERATOR* LEACH (ANISOPTERA: *AESHNIDAE*)

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The territorial behaviour of *A. imperator* was studied using a marking technique at a small pond in central Italy. The ♂♂ hold the whole pond or a definite part of it, patrolling above the water and fighting against other ♂♂, until they are displaced or leave spontaneously. The time spent by a ♂ on his territory ranges between less than 1 min. and 93 min. and shows a general trend to decrease in successive days with decreasing crowding. ♂♂ may change territory inside the pond, but some of them exhibit a preference for some part of the pond. This form of spacing pattern is compared with other ones which have recently been described in other species of dragonfly.

INTRODUCTION

Among the *Aeshnidae*, the spacing pattern of *Aeshna cyanea* (Müller) was studied using a marking technique by MAYER (1962) and KAISER (1968, 1970, 1974a, 1974b) and that of *A. subarctica* Walker and *A. juncea* (L.) by SCHMIDT (1964).

In small ponds both Mayer and Kaiser found that ♂♂ of *A. cyanea* flew alternately with each other, each remaining for a time varying with population density and defending the space over the pond against other ♂♂. The aggressiveness of the defending ♂ decreased with time, until he was displaced by another ♂. If other incoming ♂♂ were caught and thereby not allowed to meet the ♂ flying over the pond, the latter finally left spontaneously after about 100 minutes.

In larger ponds, where various ♂♂ of *A. cyanea* can be present simultaneously, each of them, according to MAYER (1962), holds a definite part of the pond, whereas KAISER (1968, 1970, 1974a, 1974b) refers to many observations from which it is shown that they have no preferences for different parts of the pond.

In *A. subarctica* and *A. juncea* flying on large ponds SCHMIDT (1964) found that only with low population density did the ♂♂ fly over separate areas which they defended against other ♂♂, but they displaced themselves gradually or abruptly if their areas were not naturally delimited. They always changed their flight path and the places in which they hovered inside their area, and this behaviour is different from that of *A. cyanea*, the ♂♂ of which fly for a long time on the same flight path, hovering in the same places.

The only author who has applied a marking technique to *Anax imperator* Leach is, as far as I know, CORBET (1957), with the aim of establishing the life span and the time which is necessary to reach the mature state. He did not study how long the ♂♂ remain above the water when they establish their "beats". It seemed to me, therefore, interesting to investigate the spacing pattern of this common species.

OBSERVATIONS

The research was carried out at a small pond, about 25 m in diameter, in the estate of Castel Porziano near Rome, on five different days from May 29 to June 14, 1974, for a total time of 1560 minutes. In ponds of this size there are usually one or more ♂♂ of *Anax imperator* patrolling at about 2-3 m above the water throughout the warmer part of the day from approximately May to September (CONSIGLIO, ARGANO & BOITANI, 1974). There are no hovering flights. At the beginning of the flight season two to four ♂♂ are often seen together, each patrolling over its own part of the pond. When a ♂ enters the range of another ♂, chases (sometimes following fights) usually occur, leading to one of the ♂♂ being extruded from that range. It was of course impossible to decide, with non-marked specimens, which of the two ♂♂ had been displaced; on the other hand, marking requires capture which is usually very hard owing to the patrolling flight occurring above the water at some distance from the banks. It was, therefore, fortunate when, on May 29, 1974, I noticed that a rise in the water level following recent rains had caused the formation of a small bay, about 3 x 3 m in size, with shallow water, on the eastern bank of the pond, above which ♂♂ had extended their patrolling flights. Standing at the entrance to the bay, I was able to capture and mark 6 ♂♂ (of which one did not return in successive days) in half an hour.

When a ♂ arrives at the pond, one of the following three events may occur:
(a) He can be immediately chased off by another ♂ and extruded from the pond.
(b) He can establish himself above the whole pond or a part of it, patrolling and defending his range against other ♂♂ entering it, i.e. chasing them off the pond or towards other parts of it. This activity will be referred to as defense of territory.
(c) He can be chased by one or more other ♂♂ above the water, without being

extruded from the pond. However, after some time one of the two above mentioned events will occur.

In calculating the time spent by ♂♂ above the water, the time spent patrolling over a territory and defending it was distinguished from that spent without having a territory. The former will be referred to as territorial time, and ranged between less than 1 minute and 93 minutes. The sum of the observed territorial times was 1100 minutes. The mean territorial time showed a general trend to decrease on successive days (11 minutes on May 29; 15 on June 3; 10 on June 5; 5 on June 10; 6 on June 14) and seems to be correlated with crowding which was also decreasing on successive days.

Since all the marked ♂♂ were seen on all the days in which observations were made until their disappearance, and no marked specimen was ever seen over other ponds in the neighbourhood, it may be assumed that each ♂ returns every day to the same pond for his reproductive activity.

Once a ♂ has established himself above a part of the pond, he usually keeps that part until he leaves the pond; but sometimes a ♂ can extend or restrict his range or displace himself from one part of the pond to another one, often spontaneously. The next time the ♂ enters the pond, he will not necessarily take the same range as the preceding time. It seemed interesting, therefore, to decide whether or not the ♂♂ have a range preference. From an analysis of the territorial times spent by ♂♂ in each of four different sector-shaped parts of the pond, one can deduce that some of them exhibit a preference for some parts, while such a preference is not clear for other ♂♂. The sum of the territorial times in parts A, B, C and D is respectively: ♂ 2L minutes 227, 25, 45, 19; ♂ 2R minutes 11, 13, 72, 109; ♂ 3L minutes 168, 1, 56, 56; ♂ 6L minutes 5, 9, 10, 13; ♂ 6R minutes 22, 9, 36, 1.

DISCUSSION

It should be noted that some authors, e.g. JOHNSON (1964), restrict the use of the word "territoriality" to the instances when ♂♂ are able to recognize ♂♂ from ♀♀ of their own species. Some doubt may be raised whether this is the case in *Anax imperator*. CORBET (1957) thinks that they do not, since some ♂♂ are found which exhibit copulation marks on their eyes; on the other hand, MAYER (1962) states that ♂♂ of *Aeshna cyanea*, which belongs to the same family, recognize other ♂♂, which they attack from underneath, from ♀♀, which they approach from above. In any case, and although the discussion of the evolution of territoriality in dragonflies by JOHNSON (1964) is excellent, I think that we can speak about territoriality when an area is actually defended, irrespective of the motivations.

It may be concluded from the obtained data that the spacing pattern of *Anax imperator* agrees with that described by MAYER (1962) and SCHMIDT (1964)

for *Aeshna cyanea*. Thus ♂♂ of *A. imperator* may exhibit some preference for a particular territory, even when 2 or more ♂♂ fly over the same pond.

The spacing pattern of *A. imperator* could be referred to as a lek, since various males return daily to a common area for mating purposes. However, the lek behaviour is usually associated with dominance phenomena, through which a dominant male obtains a territory which gives him a better chance for mating. Dominance phenomena cannot yet be ascertained in *A. imperator*.

A temporal lek was recently described by CAMPANELLA & WOLF (1974) in *Plathemis lydia* (Drury), differing from traditional leks of birds (for instance, grouse and ruff) in that the common area is divided spatially in birds and temporally in *P. lydia*. In *Anax imperator* both types are present, in that there is a temporal succession of males in a single territory, but ♂♂ may change territory inside the lek, although they exhibit some preference for a particular territory.

The spacing pattern of *Aeshna cyanea*, described by KAISER (1974b) as a "Temporium", and that of *Crocothemis erythraea* (Brullé) described by FALCHETTI & UTZERI (1974), could also be considered as leks. However Kaiser could not ascertain the existence of dominance phenomena, while Falchetti & Utzeri gave some indications for this.

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